Can We Measure the Spectroscopic Factors from Nuclear Reactions?

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The spectroscopic factor (SF) is the square of the norm of the overlap function. Hence it is mainly determined by the behavior of the overlap function in the nuclear interior. Experimentally the SFs are determined from transfer, breakup and knockout reactions. Electron induced knockout reaction $(e,e'p)$ is considered to be one of the most accurate tool to extract the phenomenological spectroscopic factor (SF) because, by increasing the electron transfer momentum, one can probe the nucleon overlap function down to very small distances. Recently we have proposed a new method to determine the spectroscopic factor from transfer reactions [1]. This method is based on the introduction into analysis the information about the asymptotic normalization coefficient (ANC). Introduction of the ANC fixes the external contribution and makes the determined SF sensitive to the coupled channels and optical potential in the internal region. Application of this combined method demonstrated the failure of the standard technique of determination of the SF. Meantime recently it has been shown in the effective field theory that it is impossible to determine the SF from the $(e,e'p)$ processes due to the existence of the infinite number of Lagrangians corresponding to different field redefinitions [2] . These Lagrangians generate different reaction amplitudes where the final state proton-residual nucleus interaction is traded in with the short-range nucleon-nucleon correlations. It is important to demonstrate a connection between our phenomenological approach and effective filed theory result. To do it we start from the nonrelativistic Schrödinger equation. We introduce a unitary transformation of the wave functions using the short-range nucleon correlation operator which is equivalent to the field redefinition. We demonstrate that such a unitary transformation does not affect the ANC but changes the overlap function and, correspondingly, the SF. As the next step we derived an explicit equation for the $(e,e'p)$ amplitude. Application of the unitary transformation generates the short-range correlations similar to those which appear in the effective filed theory. We have estimated the range of the effective potential corresponding to the short-range correlation. This correlation is described by the triangular diagram corresponding to the two-nucleon contact interaction with the external photon leading to one-nucleon knockout. A typical radius of the short-range correlation is ≤ 1.5 fm. It is important to estimate the impact of the short range correlations on the SF and $(e,e'p)$ amplitude and we are working on that.

[1] A. M. Mukhamedzhanov and F. M. Nunes, Phys. Rev. C **72**. 017602 (2005).
[2] R. J. Furnstahl and H.W. Hammer, arXiv: nucl-th/0108069 (2001).